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The Prospects of Generation of Electrical Power Using Distribution Generation

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Abstract—Distributed generation is becoming more popular now a days and is expected to be more important in the future because the availability and enhancing technologies in renewable energy generation system. In current literature however there is no accordant definition of distributed generation is available this paper discusses about a generalized definition for distributed generation. This paper also discusses about the working process and relevant issues of distributed energy generation system in the competitive electricity markets. This paper also includes the advantages and disadvantages of distributed generation system. In general distributed generation is the electricity generation within distributed networks or near customer section of the network. In addition the working conditions and present scenario of working process between conventional system and distributed generation is described briefly.

Keywords—*Distributed Generation; Types; Process; Advantages; Disadvantages.*

I. INTRODUCTION

Under the working situations and increasing load demands and growing networks of electrical distribution, in recent years the penetration of distributed generator (DG) into distribution systems has been increasing rapidly in almost every part of the world. The basic method for the measure for the energy access is either by accessibility to electricity or by the availability of clean fuel for cooking (i.e. independency from solid and traditional fuels).According to the global status report 2016 form the "Renewable Energy Policy Network for the 21st Century" (REN21) there are about 1.2 billion people around the globe i.e. about 17% of the total population doesn't have access to electricity and about 2.7 billion people i.e. about 38% of the global population is still depending upon solid and traditional fuels such as biomass.The main reason for the increase in demands and necessity of distributed generation are to make the electricity available, provide clean cooking facilities, also to avail energy for heating and cooling purposes and environmental concerns. Technological advances and various types of controlling enhancement in small generators, power electronics, suitable controlling action and energy storage devices for transient backup have also accelerated the penetration of DG into electric power generation plants [1][2].

At present, there are various types of technologies are in use for DG applications that includes traditional to nontraditional conventions. The former is nonrenewable technologies such as internal combustion engines, combined cycles, combustion turbines, and micro-turbines. The latter is renewable technologies such as hydro, solar, photovoltaic, wind, geothermal, ocean, and fuel cell. The main benefits of using distributed energy sources based of renewable energy sources are the elimination of harmful emissions and unlimited resources of the primary energy.

The Electricity Act, 2003 of India shown thrust on distributed generation especially in the context of rural and remote area electrification. The Act, in addition to grid extension as a mode for rural electrification, give regards to distributed generation and supply through stand-alone conventional and renewable energy systems. It also includes the generation and/or distribution of electricity through Non governmental organization (NGOs) local government units, community groups, private sector industries and franchisees of distribution utility as alternate modes for rural electrification [3].

II. BACKGROUND OF DISTRIBUTION GENERATION

Distributed generation is the recent approach in the electrical industries and is continuously growing in present trend with enhancing technologies and terms of reliable operation for electrifying the rural and remote areas from the central generating units. A distributed generating unit may use a conventional or non-conventional (renewable) method of generation. Generally distributed generation is connected directly to the load or to the distribution side of the transmission and distribution network.

Basically there is no generalized definition for distributed generation and fatherly no certain isolation between conventional generation and distributed generation. Distributed generator is the term used for small and medium capacity generating units that can be combine and operated together to supply loads of nearby consumers. A distributed generation concept is used to generate power from renewable sources to supply and are located at the locations near the end users.

As per The Electricity Act, 2003, Section 15.A (15A) "decentralized distributed generation" basically generation of electricity from wind, small hydro, solar, biomass, biogas, bio-fuel, generation from any kind of waste including municipal and solid waste, geothermal, hybrid power system or such other sources as may be notified by the Central Government for end-use at or near the place of generation [3].

A. Types of Energy Sources Available

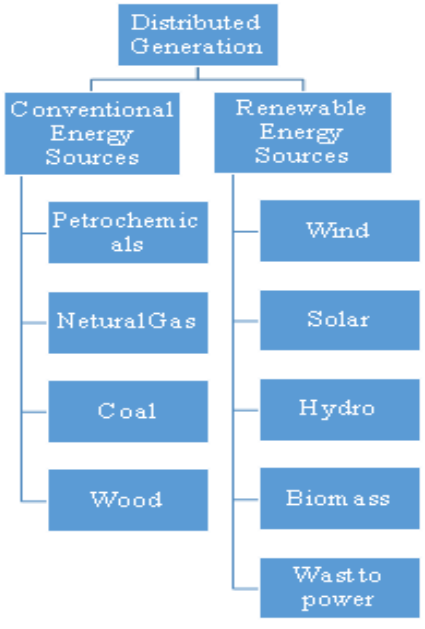

Fig. 1. Types of Energy Sources Available

The method of distributed generation consisting of various types of energy sources that can be summarized into two categories which are conventional and renewable. Use of conventional energy source is aims to the use of fossil fuels for energy transformation such as petrochemical, coal, wood whereas the renewable energy sources use the energy from resources which can be naturally refilled or recharged on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.

III. CHOICE OF DISTRIBUTED GENERATION

Definition of distribution system is affected and described according to the condition of operation and specific situation of generation as below:

A. the purpose; B. the location; C. the rating;

A. Purpose

The purpose of distributed generation is to provide an economical and reliable source of active electric power. The economic conditions depends upon the location (i.e. for the load distant loads it must be convenient to have transmission and distribution lines), whereas the reliability needs quality of various quantities (i.e. power quality, minimum voltage fluctuations, constant frequency for A.C. supplies) [1].

B. Location

The conventional way of connecting a generation unit is to the transmission network. Whereas the ideology of distribution generation is either to connect it with the distribution grid itself or directly to the load [1][4].

Hence the electrical power generating unit directly connected to the distribution grid/network or to the customer side of the meter [1].

C. Rating

There is no certain difference for the definition between centralized generation and distributed generation. Various research institutes and conferences defined different generating ratings for distributed generation which starts from a few kilo-watts to 300 MW. According to the generation capacity of the unit it can further be classified as [1],[2]

Table 1: Types Of Distributed Generation Based Upon Power Ratings

Sr. No.	Type	Lower limit	Upper limit
1.	Pico distributed generation	1 W	≤ 100W
2.	Micro distributed generation	100 W	≤ 5 kW
3.	Small distributed generation	5 kW	≤ 5 MW
4.	Medium distributed generation	5 MW	≤ 50 MW
5.	Large distributed generation	50 MW	Up to 300 MW

D. Generalised defination

Considering the above factors it can be defined as:

"The source of active power generation which is either connected to the distribution network or to the end user or consumer side of meter can be termed as distributed generator."

IV. USE OF RENEWABLE SOURCES FOR DISTRIBUTED GENERATION

Renewable energy can be defined as energy that is generated from resources which are naturally replenished on a human timescale in other words generally do not subjected to depletion, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy at present provides energy in four important areas: generation of electricity, heating/cooling of air and water, transportation, and rural (off-grid) energy services.

As per the Global Status Report 2016 from The Renewable Energy Policy Network for the 21st CenturyREN21's, renewables contributed 19.2% to the total of global energy consumption. This energy from renewable sources is further be divided as 8.9 % from traditional biomass, 4.2% from biomass, geothermal and solar heat, 3.9% from hydroelectricity and 2.2% from other sources like wind electricity farms, solar photovoltaic cells, biochemical or biomass etc. till the end of 2014. Worldwide total investments in renewable technologies are calculated about more than US$286 billion in estimated 147 gigawatt (GW) of renewable energy capacity addition in 2015, with countries like China and the United States are the largest investors in wind, hydro, solar and biofuels globally, there are an estimated 8.1 million jobs in the renewable energy sector (not including large-scale hydropower) increased in (direct and indirect) [2][5].

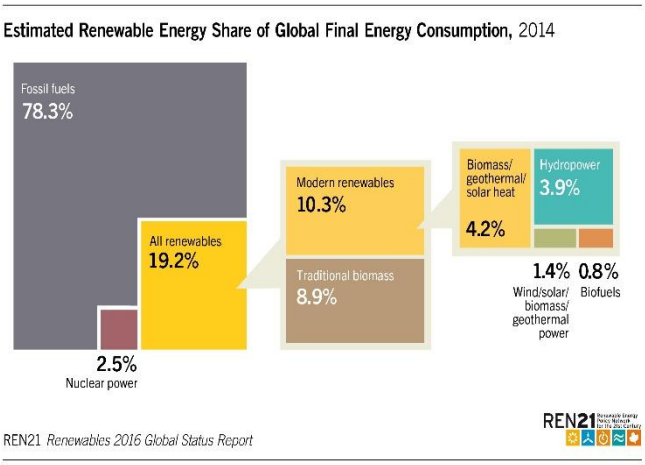

Fig. 2. Estimated Renewable Energy Share of Global Final Energy Consumption, 2014

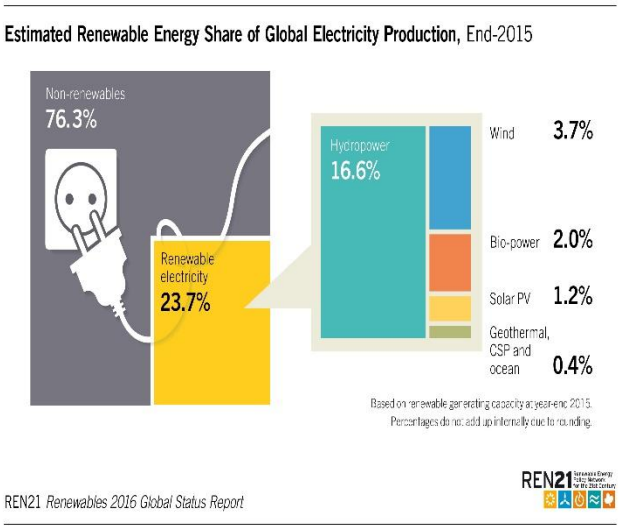

Fig. 3. Estimated Renewable Energy Share if Global Electricity Production, End-2015

A. Wind Energy

Airflows is being used to run wind turbines. Modern utility-scale wind turbines range from around 600 kW to 5 MW of

rated power and hundreds of which are producing together. The power generationvia wind turbine is a cubic function of the wind speed, hence as wind speed rises, power output increases up to the maximum output for the particular turbine.

Wind turbines with small scale (≤100 kW) often are in use for electricity generation for farms, homes and small office or business uses. Off-grid connectivity for rural electrification, telecommunication consists hybrid system of wind farm with diesel, hydro and/or solar photovoltaic system [6].

B. Hydro Power

Water is about 800 times denser as compare to air, so even a slow flowing stream of water, or moderate sea swell, can yield considerable amount of energy. There are micro and even Pico hydroelectric plants are in working with as small as 1 kW rating [6].

C. Solar Energy

Solar heating, photovoltaics, concentrated solar power (CSP), concentrator photovoltaics (CPV), solar architecture and artificial photosynthesis are the common technics for utilizing the solar energy. A photovoltaic system converts photo-energy into electrical energy direct current (DC) by taking advantage of the photoelectric effect.

The smallest scale of solar photo voltaic system is Pico-PV system (1-10 Watt), which is compact in size and easy to use. This types of systems replaces kerosene lamps, battery powered flash lights and are being used in small lights to street lightings, mobile charging to power small appliances. About 20 million Pico-solar products had been sold by mid-2015 worldwide most of which are in India and sub-Sahara Africa.

Solar Home Systems (SHS) (10-500 Watt) generally used for street lighting purpose consisting of a solar panel and a battery provided with a charge control device. Similar system with higher ratting are also available so as to supply electricity to off-grid households for lighting, radio, television, heating and cooling purpose [2].

D. Geothermal Energy

Heat energy in form of magma and liquid metals do exists in various layers and crust of earth. This heat energy from the inside layers is being used for heating and electricity generation purpose and termed as geothermal energy. This geothermal energy can be used for the production of electricity and for the purpose of direct heating and cooling as well [2].

E. Bio Energy

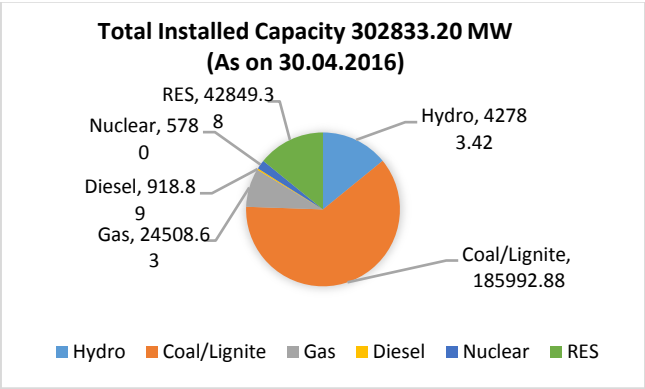

Fig. 4. Electricity genertion secnerio in india

Biomass can be converted and used into other forms of fuel like methane gas or transportation fuels like ethanol and biodiesel. Agricultural and domestic wasterelease methane gas – generally known as landfill gas or biogas. Crops as rice, corn and sugarcane, coconut can be fermented for the production of transportation fuel, ethanol and power generation as well. Biodiesel, another transportation fuel, can be produced from left-over food products like vegetable oils and animal fats [2]. Biogas systems continued to be adopted for electricity supply and cooking purpose in 2015, with Asia leading in total installations.

V. ADVANTAGES AND DISADVANTAGES OF DISTRIBUTED GENERATION

A. Reliablity

The reliability of a system is governed by the continuity of system to remain in operating condition during the duration of time cycle. Storms, rain, snow falling, falling tree branches, high speed wind, brownouts, and many other environmental and technical aspects affects the operating system. It is obvious that the less the distance of generation unit from the load center or the end user the more the reliability will be. The basic concept of distributed generation is that the generation is at nearby points to the load. Hence with the reduction in distance the reliability of the system will increase.

B. Efficient

The on-side electric power generation or distributed generation has the concept of generation at the nearest point of consumption. This concept of distributed generation system eliminates the problems of technical aspects and high cost for design of transmission and distribution networks, system complexity, saving cost for land and protecting equipment, easy fault detection and clearing. This cause allover increase in efficiency of the system.

C. Economical

The concept is that for supplying power to loads located remotely from centralized power units distributed generation technique is to be used for electrification purpose. The benefits of using distributed generation for remote loads is saving of sweats and cost for new transmission and distribution lines and also to use renewable energy sources where can be used. Further the investments and efforts required for point to point improvement in voltage and power factor can also be neglected.

D. Flexibility

Flexibility mainly depend on cost criteria. For the generation purpose the flexibility refers to the ability of the plant or unit to acquire the latest technology or to adopt the changes the required features in the system. For a centralized generating unit the costing of about all the equipment are considerably high and so even it is require to use the newly available technologies the unit can't be abandoned. Whereas in distributed generation the size and cost of each part is comparatively low a hence it is easy to have the necessary changes time to time.

E. Upgradability

Upgradation refers to the modification of existing ones or to include the latest techniques and equipment. In a large size power system the cost of equipment and existing technology is that high it is not possible to replace them even with the latest one with improved efficiency. On the other hand with smaller units the modification and replacement are easy with less sum requirements.

F. Diversity

Distributed generation allow to use various types of power generating technologies, decreasing my dependence on any one resource and even on the use of fossil fuels as the unit less land requirement and also availability. With the latest technology available, research foundations, availability of upgraded scientific technologies, there is strength in diversity.

G. Need of Distributed Generation that is Clean and Continuous

For the concern of health of leaving and non-leaving organism and of environment as well it is necessary to reduce the exhaust of harmful gases and solid west which is exhaust of conventionally used generation methods. Historically, combustion generators using diesel, coal or gas as a fuel were the means for generation of electrical energy. These means of generation were affordable, and in some cases reliable, but not clean. These means of generation are also not permanent as the fossil fuel for combustion purpose are not available for long.

CONCLUSION

This paper discuss the main role of distributed generation and its process very widely used in this scenario. This paper also considered about the available sources of renewable energy for distributed generation and focus on the definition of distributed generation. The main issues of this paper that depends on marketing condition. It is also included the advantages and disadvantages.

The connectivity of distributed generation unit with smart grid is the option for further increase in reliability and suitability for using this technique by the consumer or by end user effectively. The future of this paper is to provide information about the "SmartGrid," describe its many components, and propose some suitable attributes while considering Distributed Generation (DG)interconnection as a major integral part. The benefits from smart grid will achieve through successful implementation for the utilities as well as for consumers, and obviously benefits to the economy.

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